SYSTEM REOPERATION

System reoperation is restructuring the operation and management of water facilities to utilize the flexibility of the system to meet competing beneficial uses. Beneficial uses for waterways are established by the State Water Resources Control Board and include, for example, water supply, hydropower generation, recreation, wildlife habitat, and navigation. For each waterway the SWRCB also establishes water quality objectives based on the designated beneficial uses. Population growth with its commensurate demand for new water supplies, better understanding of the environmental impacts of water development, and changing laws and values have created incentives to figure out how existing facilities can be reoperated to provide the greatest balance to all beneficial uses. In 1983 the California Supreme Court clarified, in National Audubon Society v. Superior Court of Alpine County (1983), the State's public trust responsibilities to protect the people's common heritage of streams, lakes, marshlands and tidelands. This has provided a further catalyst for water managers to investigate how operational changes can provide additional instream benefits while minimizing reductions in other project benefits.

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Examples of system reoperation include:

- Changes in timing or volume of water storage and releases from reservoirs to accommodate changing priorities of the project, such as improving instream conditions, recreation opportunities, flood protection, local water supplies, or managing water quality.
- Using temperature control devices in reservoirs to permit water to be released from variable depths in order to manage the water temperature and water quality downstream for endangered species protection while maintaining hydroelectric power generation.
- Increasing the water storage and flood retention capacity of reservoirs by conveying reservoir water to groundwater banks before the refill season
- Coordinating water storage, water conveyance, and water delivery systems within a watershed or geographic area to provide the greatest balance of beneficial uses to the local watershed area, the regional watershed area, and the state.
- Balancing water supply and delivery forecasts with the economic and environmental risks that water users and regulatory agencies may be willing to accept if full deliveries are not met. The ability to customize risk tolerances to users may allow overall improvements in system efficiency.

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Current Extent of System Reoperation

System reoperation is not a new tool for water managers. The 1976-1977 drought prompted many water agencies to move away from the "firm yield" approach to a risk based approach when making system delivery decisions. The

firm yield approach seeks to deliver the same amount every year regardless of water supply conditions while the risk based approach balances increasing deliveries in a given year with the risk of not meeting full deliveries in a dry year. The risk based approach has increased average deliveries of the State Water Project. System reoperation is one possible strategy for improving environmental benefits while maintaining water supply, recreation, flood control, and other benefits as required by several large-scale water planning and management efforts started over the last decade. These efforts include implementation of the Central Valley Project Improvement Act (CVPIA), SWRCB Bay Delta Decision 1641, The CALFED Planning Process, hydroelectric facility relicensing, and concerns about the potential effect of global climate change.

For instance, the CVPIA, signed into law October 30, 1992, mandated changes in management of the Central Valley Project, particularly for the protection, restoration, and enhancement of fish and wildlife. This has led to changes in the terms of water supply contracts, reallocation of water for environmental benefits, increased use of voluntary water transfers, and implementation of water use efficiency measures. One example of reoperation that was prompted by CVPIA was the installation of the Temperature Control Device (TCD) at Lake Shasta Dam at a cost of $80 million. Construction began in 1996 and was completed in 1998. The TCD is a shutter type mechanism designed to draw water from the different levels of Shasta Lake and release it through powerhouse turbines, providing cold water for endangered Winter Run Chinook salmon spawning downstream in the Sacramento River, while maintaining hydroelectric power generation. Water is drawn from different levels of the lake at different times of the year to match the downstream requirements and to manage the cold water reserves behind the reservoir.

The State Water Resources Control Board adopted Decision 1641 (D-1641) on December 29, 1999. The Decision implements flow and water quality objectives for the Bay-Delta Estuary set forth in the1995 Bay-Delta Plan, adopted May 22, 1995. D-1641 recognizes that many of the objectives in the 1995 Bay-Delta Plan are best implemented by making changes in the flow of water or in the operation of export facilities. Accordingly, D-1641 includes aspects of system reoperation by approving changes to points of diversion of the Central Valley Project and the State Water Project in the Southern Delta, and approving changes in places of use and purposes of use of water developed and distributed by the Central Valley Project.

The purpose of CALFED Bay-Delta Program is to develop and implement a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta System. The Program was formalized with the approval of the Record of Decision on August 28, 2000 by the state and federal agencies with management and regulatory responsibility in the Bay-Delta Estuary. The Framework Agreement pledged that the state and federal agencies would work together in three areas of Bay-Delta management:

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1) Water quality standards formulation; 2) Coordination of State Water Project and Central Valley Project operations with regulatory requirements; and 3) Long-term solutions to problems in the Bay-Delta Estuary. All three components include system reoperation combined with other water management strategies to make improvements.

Approximately one third of hydroelectric facilities in California licensed by the Federal Energy Regulatory Commission (FERC) must undergo review and relicensing by 2015. This is significant for several reasons. First, because FERC issues licenses for a period of 30-50 years, relicensing provides an opportunity to assess and change license conditions for many facilities over a relatively short period. Second, many of these facilities were designed, constructed, and licensed before the modern environmental laws like CEQA and NEPA were in effect and before the California Supreme Court clarified, in National Audubon Society v. Superior Court of Alpine County (1983), the State's public trust responsibilities to protect the people's common heritage of streams, lakes, marshlands and tidelands. The result is that many facilities did not fully evaluate potential impacts to rivers in the timing and volume of instream flows, sediment transport, water temperature, and fish passage. Operational changes are being made during relicensing to ensure that the projects are in compliance with modern environmental laws, public trust, public policy and the public interest. Finally, many hydropower facilities are located higher up in the watersheds where other management strategies may not be options for meeting environmental, recreation, and local water supply needs. For example, geologic conditions limit the availability of groundwater to meet water supply needs for many areas in the foothills of the Sierra Nevada.

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Global climate change has also prompted discussion of system reoperation. The specific effects of global climate change on water resource management in California are uncertain. Climate change could result in altered snowpack accumulation and melting, runoff patterns, water supply, sea level, floods and droughts, water demands, water temperature, plant and animal life including livestock, hydroelectric power, wild fires, recreation, water quality, soil moisture, groundwater, and ecosystems. The California water planning community continues to evaluate climate change and study ways of incorporating flexibility and robustness into the current system to respond to climate change.

Potential Benefits of System Reoperation

The potential benefits obtained from system reoperation are project specific and statewide benefits can only be generalized. The State Water Project and Central Valley Project have integrated operations since the 1970's with annual agreements that were eventually finalized in 1986 with the signing of the Coordinated Operating Agreement. It is estimated that better integration of the State Water Project and Central Valley Project could increase average annual deliveries by 100 to 300 thousand acre-feet per year. System reoperation

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integrates multiple resource management strategies such as surface storage, conveyance facilities, conjunctive management, water-dependent recreation and ecosystem restoration, which can:

- Reduce conflicts between competing beneficial uses and allow for improvements to the beneficial uses including environmental, recreational, water quality, and water supply objectives.
- Provide additional flexibility to respond to extreme hydrologic events like flood and drought or catastrophic events like earthquakes.

Potential Costs of System Reoperation

The potential direct costs for implementing system reoperation are project specific and are difficult to extrapolate to a statewide estimate. Up-front costs may include performing the feasibility studies, completing CEQA/NEPA analysis, and undergoing water rights permitting to implement a proposed change in operation. These studies alone can cost millions of dollars and take several years to complete. Long-term costs may include capital costs for the construction, modification, or removal of facilities, loss of revenue from reduction in sale of hydropower or water supplies, and increased operations and maintenance costs. However, the costs to reoperate existing facilities are significantly less than the costs to develop new surface storage when it is a feasible alternative. New facilities may provide more flexibility to the overall management of the system.

Case Example of System Reoperation – El Dorado Irrigation District's Project 184

An example from El Dorado Irrigation District's (EID's) Project 184 highlights the potential benefits, costs, and issues surrounding system reoperation as part of FERC relicensing[1]. In 1999, the El Dorado Project 184, including all related permits and licenses, was acquired by EID from PG&E. Project 184 is a 21 Megawatt hydroelectric and water supply project owned and operated by El Dorado Irrigation District and is located on the South Fork of the American River and its tributaries, and on Echo Creek, a tributary to the Upper Truckee River, in the Counties of El Dorado, Alpine, and Amador, California. The relicensing of the El Dorado Project involved a collaborative process undertaken by EID to provide significantly enhanced environmental protection, improving recreational opportunities and for assuring the long-term reliability and economic viability of local water supply.

In February 2000, EID filed an application to renew its license with FERC. The collaborative process included regulatory agencies, interest groups and

[1] This section is based on information provided by John S. Kessler, Principal - Kessler and Associates, LLC, in cooperation with El Dorado Irrigation District.

individuals to study project effects on the environment and for developing conditions for a new license. In April 2003, the collaborative effort produced a settlement agreement, which has been filed with FERC as recommendations for establishing conditions for the new license. Costs associated with this effort are shown in Table 1. The following new conditions were proposed for the project in the settlement agreement:

- Lake Level criteria for improved recreation opportunities;
- Improved aquatic habitat via new stream flow criteria in more reaches of stream;
- Pulse flows in regulated reaches to mimic natural hydrologic condition peak flows;
- Recreation facility improvements including a new boat ramp, campground access improvements, whitewater boating access improvements;
- Fish screens at diversions from Alder and Carpenter Creeks;
- Public information system of real-time lake and flow data via internet & phone;
- Stream restoration in previously scoured reaches;
- Sensitive species, fish and water quality monitoring;
- Various environmental protection plans for O&M and future capital projects;
- Ecological resources adaptive management program;

Table 1. El Dorado Project 184 Case Study - Before & After Relicensing

Description	Before	After
Generation (gigawatt-hours/year)	106.6	92.8
O&M ($million/year)	$2	$2.2
Capital ($million/year)	$1 - 2	$1 – 2
Relicensing Application ($million)	$0	$6.8
Relicensing Implementation ($million)	$0	$10 – 20
Relicensing Adaptive Management ($million/year)	$0	$0.3
Net Revenues ($million/year)	$0.7 to $1.3	- $0.2 to $0.4

Although implementation of the new license conditions may result in a slight deficit on average depending on future power values, revenues from power generation can be augmented with revenues from consumptive water deliveries in order to fund project costs. EID benefits by maintaining the power generation features of the project because the power facilities represent a small fraction of project O&M and capital improvement costs, while revenues from hydroelectric power generation offset the majority of project costs which are largely driven by the cost of water conveyance, an integral system component that would exist with or without power generation capability.

Even with the collaborative process and settlement agreement, the proposed reoperation is not entirely free of controversy. At least one interested party

representing some of the recreation and business interests around Caples and Silver Lakes has not signed on to the settlement agreement because of concerns about potential economic and quality of life impacts from the revised operation. Although lake level and streamflow conditions under the system reoperation would generally be enhanced for recreation interests compared to historic project operations, disagreement continues for this group over what lake levels should be maintained during the summer and fall recreation season, if the lakes refill from year to year, and how low lake levels will be allowed to drop during dry years. The Board of Supervisors for Alpine and Amador counties (located in the project area), resource protection agencies, and river conservation agencies have agreed to the settlement and consider it to be an acceptable balance of benefits for protecting recreation, water supply, power generation and environmental quality. While the settlement agreement for reoperation of the El Dorado Project did not achieve agreement for all parties, EID believes it is likely FERC will adopt the provisions of the settlement agreement into a new license in recognition of the foundation for resource allocations and overall broad support from government and resource protection agencies and other interested parties.

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Major Issues Facing System Reoperation

Reduced Hydropower Generation – System reoperation has the potential of shifting some water use from power generation to other beneficial uses. Preliminary analyses by the California Energy Commission indicate that project specific and cumulative losses associated with FERC relicensing to date are not significant on a system wide basis in California. Many facilities must still undergo relicensing and the effects of these on energy generation must be evaluated. Improved generating equipment and technology can offset some of this energy reduction. There may be a need to provide for alternative sources of energy to make up any reduction in hydropower generation. If done on a large scale, switching to fossil fuels to offset this loss could increase air pollution, and reliance on imported energy sources. There are numerous dams throughout the state without hydropower generation. Opportunities to reoperate these facilities for water and energy demands without additional environmental damage could be explored.

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Gaps in Scientific Knowledge and Data – There are several significant knowledge gaps that should be addressed to improve the likelihood of successful system reoperation. First, there is a need for greater understanding of the relationships between flow patterns and the response of aquatic ecosystems and how these relate to protecting public trust resources. While this area of applied environmental science is developing quickly, there is a need to improve the understanding of the effects of pulsed and ramped flows upon endangered species, other aquatic species, habitats, and river morphology. Lack of baseline data and good bio-hydrologic models for some ecological components are limiting factors. Biological opinions issued by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service provide some guidance on specific

changes in operation that would benefit the specific endangered species covered by the opinion.

Second, there is also a gap in the understanding of the specific effects associated with global climate change on local water systems. Changes in the timing and distribution of precipitation and runoff within the state may create greater uncertainty, potentially requiring changes to the management of the water system.

Third, there is a need for improved runoff prediction and decision support systems to balance competing water needs.

Competing Beneficial Uses – In some cases, the analysis of reservoir reoperation can be as complex and controversial as that associated with new facility construction. Because many water facilities have been operating the same way for decades, it is important to consider the interests of current beneficiaries before introducing dramatic changes. For example, many reservoirs have existing uses including recreation, summer homes, wetland habitat, fisheries, etc. There may be opposition to reoperation from those who benefit from the current operation. In addition, reoperation could have unintended impacts to existing ecological processes that must be evaluated. There is concern about potential direct and indirect impacts on other users including downstream water rights, the environment, recreational uses, and energy production.

A collaborative planning approach with all interested parties can help lessen conflicts associated with reoperation of facilities. Problems can arise during collaboration when advocacy groups are not allowed to fully participate or when there is uncertainty over the role and responsibility of regulatory agencies.

Conveyance Constraints – The capacity of reservoir outlets, storage, pumping, and conveyance may limit the ability to perform system reoperation through water transfers, conjunctive management, revised flood operations, and other strategies.

Area of Origin Water Rights – Historically, area of origin water rights have not been widely exercised, but they are increasingly of interest as rural counties develop. It may be possible for these areas to develop agreements with project operators to meet some of these projected demands through reoperation of existing facilities rather than through construction of new facilities. However, new facilities may provide more flexibility to the overall management of the system. Agreements with existing facility operators to change operations would need to consider existing uses.

Integrating Water Resource Management – There are many tiers of management of developed water resources. These include facilities that are

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operated for local, regional, or statewide beneficial uses. Implementing system reoperation to obtain wider system benefits can require regulatory actions by several local, State, and federal agencies. For example, hydropower relicensing may include actions by the California Department of Fish and Game, the State Water Resources Control Board, the U. S. Forest Service, U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Federal Energy Regulatory Commission. Efforts to increase coordination among both the physical operation of the facilities and the agencies that regulate them, may result in greater opportunities to achieve broader benefits within each watershed. This is the goal of integrated resource planning efforts.

Implementation Costs – Significant up-front and on-going costs can be involved with system reoperation. Costs may include developing monitoring systems, hydrologic models, decision support systems, and collecting data to evaluate benefits and impacts of proposed changes. Other costs are associated with conducting feasibility studies, completing CEQA/NEPA analysis, and constructing new or modifying or removing existing facilities. Agencies may have difficulty raising the needed funds due to existing contracts or regulations that prohibit them from increasing water or energy rates.

Water Quality – Water quality may restrict the ability to modify existing operations for other benefits. For example, the need to maintain cold water temperature reserves in reservoirs for downstream fisheries may prohibit reducing reservoir storage levels during the certain seasons for water supply. Reoperation using surface water to actively recharge groundwater banks may be limited by existing groundwater or recharge water quality. Water quality is often more critical for reoperation for local benefits than for regional and statewide benefits.

Recommendations to Further System Reoperation

1. The following recommendations are derived from the California Energy Commission's Public Interest Energy Research Program to gain a better understanding of the effects of flow release patterns on California stream habitats and biotic communities:
    a. Review the quality and available scientific data on the ecological impacts.
    b. Determine the adequacy of current and new sampling and analytical methods to detect and predict potential effects.
    c. Develop a recommended protocol for assessing possible ecological impacts.
    d. Develop and disseminate research to enhance scientific understanding and assessment of effects.
2. Provide financial and technical assistance for activities, feasibility studies, and construction of facilities that enhance management of water resources through system reoperation. Assistance is needed to develop data, modeling

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tools, conduct hydrologic and biological studies, develop collaborative processes to evaluate integrated management of facilities, evaluate the constraints to system reoperation, and evaluate the potential project specific and cumulative benefits and impacts to beneficial uses that may occur from system reoperation of local facilities including affects on water supply, the environment, public trust resources, recreation, statewide energy generation, and navigation.

3. Give priority for funding and technical assistance to System Reoperation projects with multiple benefits. For example, projects that increase water supplies, maintain or improve water quality, enhance the environment, and provide water for the Environmental Water Account.
4. Continue to study the potential impacts of global climate change on water management in California and develop potential strategies to respond to these impacts.
5. Improve runoff forecasting and decision support systems for reservoir reoperation to mange water resources among competing demands.
6. Support research in improving our understanding of flow alteration effects on aquatic ecosystems as well as develop management tools to address these effects.
7. Operators of water projects and facilities should evaluate the potential project specific and cumulative benefits and impacts to beneficial uses that may occur from system reoperation of federal, state or local facilities including effects on water supply, the environment, public trust resources, recreation, statewide energy generation, and navigation. State agencies carrying out or approving reoperation must exercise their public trust responsibilities to protect trust resources where feasible.

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